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FROM THE PEPPER LABORATORY OF CLINICAL MEDICINE.

No. 2.

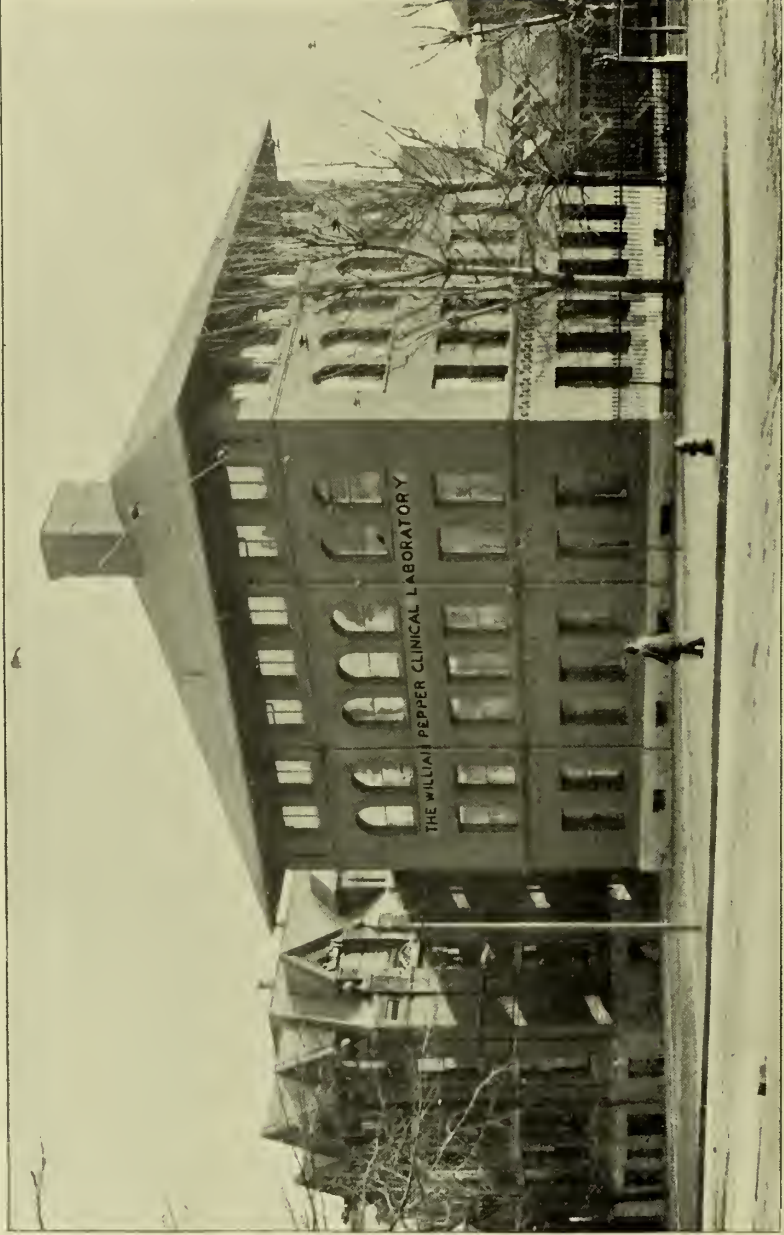
PROCEEDINGS AT THE OPENING
OF THE
WILLIAM PEPPER
LABORATORY OF CLINICAL MEDICINE,
DECEMBER 4, 1895.

1. ADDRESS BY JOHN S. BILLINGS, M.D., LL.D.,
Professor of Hygiene, University of Pennsylvania; Director of the University Hospital.
2. ADDRESS BY CHARLES C. HARRISON, A.M.,
Provost of the University of Pennsylvania.
3. ADDRESS BY WILLIAM H. WELCH, M.D., LL.D.,
Professor of Pathology, Johns Hopkins University.

PHILADELPHIA.

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1. ADDRESS BY DR. JOHN S. BILLINGS.

LADIES AND GENTLEMEN,—I have been honored by Dr. Pepper with the request that I shall, in his name, formally present to-day to the University Hospital, and through it to the University of Pennsylvania, the William Pepper Laboratory of Clinical Medicine, which is now completed and ready to begin its important work.

In complying with this request I fully appreciate the truth of the remark of Dr. Weir Mitchell, upon a somewhat similar occasion, with regard to the sensation of joy which one has in being not only able, but willing, to give on such a royal scale, when presenting another man's gift.

Now, what is this gift? That part of it which is material and visible to-day is a building sixty-two feet long, forty-two feet wide, and four stories high, with a basement cellar: built of brick and terra-cotta on a stone base to the first floor, with a green slate roof; and fitted up inside with tables, work-benches, and apparatus of various kinds. You have all, no doubt, seen its exterior, and will, I think, agree with me that while it is simple and unpretentious, it harmonizes well with the adjacent building, and forms a very satisfactory terminal on the west to the range of hospital buildings. Great credit is due to the architects, Messrs. Cope & Stewardson, for the manner in which they have solved this problem, which was a difficult one when the character and appearance of the other buildings on the east are taken into consideration.

I remember very well when Mr. Cope, Dr. Pepper, and myself were standing on the north side of Spruce Street, opposite the proposed site for the laboratory, and Dr. Pepper, waving his hand towards the heterogeneous conglomeration of façades of the then existing buildings, said, "Now, what we want is a design which will pull all this together." And then there came into Mr. Cope's face that peculiar expression in which the eyes lose their sparkle and are directed to distant space, and the corners of the mouth drop a little, the expression which you all know means "I don't see it."

Nevertheless he has produced, to a considerable extent, the desired

effect, although perhaps he would say that it has been done not so much by "pulling together" as by "pressing together" between the designs of the laboratory on the west and of the new Agnew Memorial Building on the east. It is worth your while to look at the result as seen from the northwest corner of Thirty-sixth and Spruce Streets.

The essential idea of the plan of this laboratory is a central bundle of perpendicular tubes or flues forming a large chimney stack, around which the work-rooms are so arranged that each one has its own flue on its inner face and an abundance of light on its outer face. The purposes of the several rooms are indicated on the diagram before you. On the first floor above the basement are rooms for microscopical, for chemical, and for bacteriological investigations of the secretions, excretions, outgrowths, discharges, and other products from the bodies of the sick; with a balance-room. On the second floor are rooms for anthropometrical work and research, the laboratory of the director and his assistant, and a store-room. On the third floor is a large laboratory for post-graduate students, and a dark-room for photographers' work. On the fourth floor are a research room for special workers, an assembly-room, a library, and a janitor's room. Corridors connect each floor with the adjacent hospital pavilions, which will be devoted to medical cases. One of these corridors will make an excellent photograph gallery, a dark-room being provided in the laboratory. The building is heated by steam and at present lighted by gas. The simple fittings of the rooms, benches, tables, hoods, etc., you will see for yourselves when you visit the building, as I hope you will do, after the addresses in this amphitheatre are concluded.

All this, however, by itself is merely dead mechanism, and a still more important part of the gift is still to be mentioned, namely, that which provides for brains to make use of it, and for the making of public utility the results obtained by the conjunction and co-ordination of brains, building, apparatus, and opportunity. Each of these things is required to produce satisfactory results from a laboratory, but this does not seem to be as generally well understood as it should be. I have heard of a case, for example, in which a certain university offered to a distinguished professor in another university a much larger salary than that which he was receiving to come and

establish his department of teaching in the new locality, and the professor accepted the offer. But he was a laboratory man, and believed in practical laboratory teaching and work, which had given him his reputation; so when he went to his new field of work and found that there was no laboratory and no apparatus, nothing, in fact, for teaching purposes but a few diagrams, he immediately set to work to make plans for a laboratory and lists of apparatus required for the students and took them to the president that they might be provided. When these were brought before the ruling authorities of that university they were greatly astonished, and said, "How is this? Do we not pay a high salary to secure this distinguished professor, and now are further demands to be made? No! no! the students will come, attracted by his reputation, and he can lecture to them in the big lecture-room, and that is all we want." And that professor departed a sadder and a wiser man.

Dr. Pepper, however, has provided an endowment as well as a building, and this endowment consists partly of money and partly of some of his own brain-work by way of commencement. That you may understand this more clearly, I will refer to one of the points of his terms of gift, which terms were accepted by the authorities of the hospital and of the University. The gift consisted of fifty thousand dollars, one-half of which was to be used in building the laboratory and the other half invested as a special endowment fund. The director and assistant director of the laboratory are to be appointed annually by the board of managers of the University Hospital, upon the nomination of the professor of the theory and practice of medicine and of the professor of clinical medicine, in the medical faculty of the University. The present director, duly appointed in accordance with this condition, is Dr. William Pepper, and therefore, as I said, some of his own brain-work is to be available as part of the endowment, for many years to come, let us hope. Further stipulations I will give presently, in his own words. Dr. Pepper's letter of gift, dated February 24, 1894, closes as follows: "It is my intention, should my life and strength be preserved, to supplement this foundation by a further endowment for the purchase of apparatus and the publication of scientific memoirs."

Having thus told you briefly what this gift consists of, I will now proceed to answer two questions which no doubt many of you have

asked, namely, 1. Why did Dr. Pepper make this gift? 2. What are the main purposes of the gift, the objects to be kept in view in its future management?

These two questions are not always quite the same, but in this case the answers cover nearly the same ground. The history of the first conception and gradual development of an idea, until it takes definite shape and form and develops action, is sometimes very interesting, and, as I have known something of the way in which during the last ten years this particular idea has taken shape, I have asked Dr. Pepper to give me a sketch of the process, which he has done in the following letter. Those passages in it which refer to myself I asked Dr. Pepper's permission to omit, but this permission was sternly refused, and I can only ask you to remember that it is he who now speaks, and that I am merely his mouth-piece.

1811 SPRUCE STREET, PHILADELPHIA,
December 3, 1895.

MY DEAR DR. BILLINGS,—In response to your request that I would write a letter to you, as director of the University Hospital, stating my purpose and wishes in establishing this laboratory of clinical medicine, I have prepared, with considerable hesitation, the following statement.

My father, the late William Pepper, held the chair of the theory and practice of medicine and of clinical medicine in the University of Pennsylvania from 1860 until the spring of 1864, when he was forced to resign by the progress of the disease which caused his death on October 10, 1864, in the fifty-fifth year of his age.

Already at that time a few young men had formed the definite hope of reforming the system of medical education in America, and of placing it on the sound basis of clinical teaching. I can say for some of them, including my brother George, who died in 1872, at the age of thirty-two years, after a brilliant and all too short career, that the eloquent advocacy of clinical teaching and its effective application by my father supplied at once the inspiration and the exemplar. Both father and son wore themselves out in the service of humanity and science, and fell victims to the terrible scourge of pulmonary consumption.

It is not necessary to review the long and weary struggle for

reform in medical education which has only now ended. The rôle played by the University of Pennsylvania has been a proud one, as befitted her traditions and her obligations. The names of Edward Rhoads, of Horace Binney Hare, of John S. Parry, of William F. Jenks, should not fail of mention, although they fell early in the struggle; for these were brave spirits, who dared to aspire greatly. And other names, Leidy and Agnew of the immortals; and Stillé and Weir Mitchell, still happily preserved to us in their rare intellectual vigor; and Wood and Norris and Tyson, my life-long colleagues, must be named with grateful tribute for their labors in the cause of higher medical education, and of clinical teaching and scientific research.

It was our fond dream, in those early days, that a happy time would come when well-equipped laboratories with adequate endowment would offer the chance of original investigation which was then denied. Horace Hare fitted himself by long and costly training for the special work of chemical research in the field of clinical medicine. His gifts and attainments were worthy of his descent from America's first great chemist, Robert Hare. As chairman of the building committee of this hospital in 1872, I planned some small rooms around the base of this amphitheatre where you now stand; and I can recall vividly the pleasure with which I gave the necessary equipment to have the best of these rooms ready for Hare when he returned in 1875 from the laboratory of Ludwig in Leipsic.

He was gratified, and entered at once with enthusiasm upon important chemical researches in connection with cases of disease in the hospital wards. In less than one year pulmonary consumption attacked him, and he died in 1878. Parry and then Jenks succumbed to the same affection, while Rhoads, one of the most beloved of our little group, died of organic heart-disease. You cannot wonder that I registered a vow to do what I could to secure the erection and endowment of a special department of the University Hospital for chronic diseases of the lungs and heart, and a laboratory of clinical medicine to promote original research into the causes and nature of disease. At a meeting of the board of managers held August 12, 1879, a memorial setting forth the necessity of provision for those suffering from chronic diseases of the chest was formally approved, and it was resolved that a special ward should be opened so soon as

the sum of one hundred thousand dollars was available. It was with special reference to this undertaking that the annual charity ball was established, and over twelve thousand dollars was secured the first year for the new department of this hospital. In addition to this, the funds necessary to endow seventeen beds in perpetuity, amounting to eighty-five thousand dollars, were contributed by generous men and women; and then a noble-hearted man, Henry C. Gibson, came forward with the proposal to erect a separate wing to be devoted to the care of patients with consumption and other chronic diseases of the chest. It was you, Mr. Director, who prepared the plans of the Gibson wing, a structure which will commemorate so long as the University of Pennsylvania shall endure the name and good deeds of one of the best friends the University has ever possessed. It is true it has been impossible to devote this wing exclusively to these cases until now, when the completion of the new surgical wing of the hospital will permit proper classification and arrangement of patients. I cannot refrain from the briefest mention of the legacy of sixty thousand dollars of my cousin, Henry Seybert, to endow a ward in the Gibson wing for chronic diseases, and of the much larger bequest made by two noble women, which have not yet become operative.

The most important step was taken when I learned one morning in 1889 that it might be possible to secure to Philadelphia and to the University the services of Dr. John S. Billings. Before evening Mr. Henry C. Lea had responded to an earnest appeal that he would increase a previously contemplated gift to equip a small laboratory of hygiene to an amount sufficient to erect a complete laboratory. His conditions were that if an additional sum of two hundred thousand dollars were secured for endowment; if Dr. Billings were secured as director of the laboratory; if the study of hygiene were made obligatory on students of medicine, of dentistry, and of certain other branches, he would erect at his expense a laboratory of hygiene, at a cost of not less than fifty thousand dollars. I was at your house in Washington before breakfast the next morning, and we drew up and signed an agreement, the operation of which has been the establishment of the most complete laboratory of hygiene in America, under your direction, and the rapid advancement of this hospital, under your administration, to a very high level of efficiency. Henry C.

Gibson contributed twenty-five thousand dollars towards the laboratory fund,—many generous friends co-operated,—but the fund had reached only the figures of one hundred and forty thousand dollars when sixty thousand dollars* was received from George S. Pepper, coupled with the condition that I should designate the particular chair which should be endowed therewith. Not one moment's hesitation did I feel in naming the chair of hygiene.

Even this, however, did not complete our compliance with the wise though stringent conditions imposed by Mr. Lea. He had stipulated further that when the requisite amount of two hundred thousand dollars was secured for the endowment of the laboratory of hygiene an effort should be made to obtain subscriptions of money sufficient to justify the board of trustees and the medical faculty of the University in raising the standard of medical study and in prolonging the course to four years. In order to secure compliance with this final condition it was deemed necessary that a subscription of fifty thousand dollars should be made to the medical department, and that an additional guarantee of twenty thousand dollars per annum for five years should be secured. This was done, and it was only reasonable that it should be done. Any one who appreciates the commanding influence exerted by the medical department of the University of Pennsylvania will realize that it was essential for the establishment of higher medical education throughout this continent that it should be demonstrated here that such advance could be made and could be maintained with good practical results. As a matter of fact the result of the important change was unexpectedly gratifying. The increased attractiveness of the longer and more practical course of instruction inaugurated outweighed the much greater cost and difficulty of securing the degree. The receipts of the medical school did not fall off; no part of the guarantee fund was called; and the medical faculty cordially assented, by resolution adopted February 20, 1894, to the proposal that my subscription of fifty thousand dollars should be applied to the erection and partial endowment of a laboratory of clinical medicine. The board of trustees of the University and the managers of the University Hospital and the medical faculty con-

* The proportionate share of the residuary estate of Mr. Pepper subsequently accruing has increased the amount of this legacy to ninety thousand dollars.

curred cordially in approving the conditions connected with the proposed foundation; and I quote the following paragraphs from a communication bearing date of February 24, 1894:

"That the said laboratory shall be erected in accordance with plans prepared by Dr. Billings, the director of the hospital, and on the site designated by the managers of the University Hospital, and shall be supplied with heat and light from the hospital plant without cost to said laboratory.

"*Fifth.*—That the said laboratory shall be always styled and designated as the William Pepper Laboratory of Clinical Medicine, it being my intention to hereby create a memorial for my father.

"*Sixth.*—That the director and assistant director of said laboratory shall at all times be appointed annually by the board of managers of the University Hospital upon the nomination of the professor of the theory and practice of medicine and of the professor of clinical medicine.

"*Seventh.*—That the purpose of said laboratory shall be to promote the interests of the patients in the said University Hospital by the prosecution of minute clinical studies and original researches, and to advance the interests of science by the publication of the results of such work.

"It is accordingly stipulated that at no time shall any teaching be given therein to undergraduate students, or to any students except our own graduates or the graduates of other approved medical schools, whose curriculum is at least of equal length and grade with that of the medical department of the University of Pennsylvania.

"Provisions will also be made for advanced workers engaged in original research."

There seems to be every reason to hope that the building thus constructed upon plans provided by you will prove well adapted for the purpose in view. I desire to take this occasion to express publicly my sincere thanks to you for the unwearying care and cordial sympathy you have extended to the work at every stage and in every phase of its progress. That the restriction of the use of the laboratory to original research and to post-graduate instruction has secured general approval, and has already met a recognized need, may be judged from the fact that nine associates have already received appointments, and have been assigned to distinct fields of original

investigation. It is superfluous to observe that the small amount of endowment which I have thus far been able to contribute (\$25,000) is wholly inadequate for the maintenance of the work. It has been estimated that to pay the necessary salaries; to provide annual stipends to a certain number of the associates; to supply the costly apparatus required; to issue the numerous publications resulting from the researches therein conducted; to purchase the necessary journals and works of reference; to meet the current expenses; will require the income of an endowment fund of at least two hundred thousand dollars. While I shall reckon it a privilege to supply as much of this sum as my continued professional labors may render possible, I hope it is not unseemly to indicate two directions in which contributions might be made with great effect to promote the work to be here conducted. A fellowship in clinical medicine may be established by a gift of ten thousand dollars, subject to the statutes of the University, the income of which would defray the living expenses of the incumbent and would also provide a fair sum to maintain his place in the laboratory. A gift of five thousand dollars would yield income sufficient to meet either one or the other of these objects, as might be indicated by the donor. To any one interested in the study of any special disease or group of diseases, such as tuberculosis or heart-disease or infectious fevers,—all of which destroy so many thousands of precious lives annually,—the advantages of establishing a special research fund must seem obvious. I earnestly trust that such endowments will gradually accumulate around this laboratory. The special trust created would be administered scrupulously by the trustees of the University. The good results would be far reaching and enduring. It is indeed hard to conceive in what way we, whose dearest and most cherished interests will be affected vitally by the results of such researches as will be conducted here, can better display our sorrow for the dead and our love for the living than by strengthening the resources of such institutions as this which is to be opened formally to-day. May it long endure to promote the interests of suffering humanity and to enlarge the boundaries of medical science.

I beg to remain,

Your obedient servant,

WILLIAM PEPPER.

I beg leave, Mr. Provost and gentlemen of the board of managers, in the name of Dr. William Pepper, to present to you and ask your acceptance of this laboratory and its endowment for the purposes named in his letter just read.

Thus far I have been speaking as the representative of Dr. Pepper, but now I have a few words to say in another capacity, speaking as the director of this hospital.

Many gifts of and to hospitals have been made by generous philanthropists in the United States during the last twenty-five years, and in the list of such givers the names of some citizens of Philadelphia have a prominent place. But this gift is unique in this, that it is made for the specific purpose of promoting and stimulating original research and improvements in methods of diagnosing and treating the diseases of human beings and of giving advanced and special practical instruction in the new methods to post-graduates, that is, to men who have already obtained the degree of doctor of medicine.

While a few hospitals have rooms set apart for chemical, microscopical, and bacteriological investigations, no hospital, so far as I know, has ever before received a specific gift for the construction and maintenance of a separate building to be devoted entirely to such purposes and to post-graduate teaching of clinical laboratory methods, and I count it as a singularly fortunate thing for this hospital that it should have now been selected as the recipient of such a gift.

One of the great purposes of this hospital, second in importance only to its work in relieving suffering and prolonging life, is the education of skilled physicians and surgeons, and of trained nurses, for the benefit of the people of this city, this State, and this country—present and to come. This gift emphasizes, and promises powerful aid to, a third purpose, which should always be kept in view in such a hospital as this, namely, the increase of knowledge for the benefit of the sick and suffering all over the world, whether they be high or low, rich or poor, dwellers in a palace or in a “Hotel Dieu.” Moreover, this third purpose not only does not interfere with the first and second purposes to which I have just referred, but it powerfully promotes them, because the best teaching is that which is given in connection with research work, which thus stimulates investigation, accurate observation, and independent thinking on the part of the pupils; and because the most careful and painstaking application of

the best known methods of practice is a necessity in a teaching hospital where keen eyes are watching the methods and results.

The importance and value of such an addition as this to the resources of this hospital is highly appreciated by its board of managers and medical staff, and in their behalf I offer to Dr. Pepper sincere thanks for his splendid gift.

I have also a word to say as a member of the medical faculty of the University of Pennsylvania, the oldest faculty of its kind in the United States. For more than a century this medical school has maintained the high reputation which it acquired at first from the work of Morgan, Rush, Shippen, and others, and has always been, as it is to-day, one of the most advanced and at the same time one of the most popular institutions of its kind in this country. This amphitheatre in which we are assembled is but a recent affair in its history, being only about sixteen years old; yet there are to-day scattered over this country thousands of physicians who received their instruction in clinical medicine on these benches, and hundreds of thousands of people who rely upon these physicians in time of sickness.

The medical faculty is responsible to the public and to the medical profession for the quality and quantity of the instruction which it gives, and for the qualifications for practice possessed by the young men whom it indorses by its recommendation for the degree of doctor of medicine. Its standard has always been high, but I feel safe in predicting that in the near future this standard both for admission and for degree will be raised still higher, and that in its future work on a higher plane this laboratory will play an important part. Our friend, Dr. Welch, will presently tell you of some of the scientific and educational aspects and outlooks of such a laboratory as this, and no man in this country can speak upon this subject with more authority than he; hence on this point I will say no more. I have only alluded to it that you may understand why this gift is so highly appreciated by the medical faculty, in whose behalf I assure Dr. Pepper of the gratitude of his comrades and fellow-workers.

I have yet a few words to say as an individual, and not as an official. The letter of Dr. Pepper which I have read to you needs no comment, and very few words of praise from me are either needful or proper to be spoken to this audience of his friends. Broad

and far has been his outlook in thus providing for the future a heritage of power, which mildew, flame, and frost cannot harm. It is not a statue or carving or memorial arch that he has given, things that will blacken and moulder and crumble as the centuries roll by, until the mills of the gods shall have ground them to dust. It is a perpetual well-spring of force, a storage battery which will fill itself and give out warmth and light and motion so long as this institution of learning shall exist on the earth. He says, and says it with authority, find me the means of making the lives of men longer and more efficient,—of putting aside the plague that has destroyed our fathers and brothers and threatens to consume our children; his demand is not for the fruit which is known and harvested, but for that of regions yet unknown and unexplored, for which he provides the seed, for charts of dangerous bays and coast lines still unsounded and not yet triangulated.

The taking such a step as this requires not only the opportunity of means, but also wisdom, courage, faith; wisdom, as regards selection of the unknown regions to be explored, and in providing motive power and guidance for the work to be done; courage, in investing funds in an enterprise the precise results of which cannot be predicted; and faith, in the future progress of science and in the future managers of this important trust.

But wisdom shall be justified by her children, and this far-seeing, bold-planning man of the silver tongue and the open hand will be remembered as the founder of the first distinctive laboratory for research in clinical medicine in this country, so long as there are sickness and death among the children of men.

2. ADDRESS BY PROVOST HARRISON.

DR. PEPPER, LADIES, AND GENTLEMEN,—Upon such an occasion as this the simplest words are the best ; and, indeed, it seems to me that it would be hard to find one more deserving of dignified, simple, and quiet ceremony. My own memory goes fully back to the work of the man taken away in early middle life by the disease dreaded above all others by the Anglo-Saxon race,—the man in whose memory this building has been erected and is to-day dedicated. His eldest son was my classmate in this University ; together we were members of the same society ; and after he had been graduated I watched him in his too brief career. He fell a victim to the same disease ; father and son both cut off in early life. I do not wish to intrude into the sacred circle of home anxiety, but may we not assume that the facts which I now record gave constant rise to anxious thought, and is there any doubt that there has been for many, many years an underlying principle of benevolent activity growing out of the death of father and brother, which is at the last reverently realized here to-day ? It must be so ; and the deepest satisfaction which all of us can feel must arise from the reflection that through the son who has survived, and who has done this deed of mercy, neither father nor brother would have lived in vain even if they themselves had contributed nothing to benefit the world. May he not now feel that in death he and they are not divided ? And as these thoughts arise in our minds, will not the most fervent wish of each one of us be that in the providence of God the research work to be conducted here and in this University may find a counter-agent for consumption ? Surely that will some day come.

Not long ago, before a great scientific body, its most distinguished officer said that the extent of our knowledge is like a small oasis, surrounded on all sides by a vast region of impenetrable mystery yet unexplored. “Successive generations win a small strip from the desert and push forward the boundaries of knowledge.” To advance these outposts many forces of science are at work in this University,

which is so dear to us all, and which we all trust may be controlled by that spirit of wisdom which is modest in that she knows no more. The chemist is diligently interrogating nature in her manifold riches. The physicist is studying forces and devising apparatus whereby they may be measured or applied with unerring accuracy. The bacteriologist is penetrating the mysteries of that lowest life which so influences for good or ill all higher forms of life; but here at the last are gathered into one supreme application all that these other sciences have produced—to relieve or to remove human suffering, to save human life. This is the highest mission to which the discoveries of science can be applied.

The University's duty is not only to maintain and press forward the intellectual and moral standards of the nation, to direct and control its social energies, but to touch life at every point and to help it. The mitigation of suffering, the prolongation of life, the prevention of disease, are of its highest functions. In this hospital and in this place may science always come into union with benevolence. May one of the old meanings of the word which describes this laboratory be ever realized here. May the baptism of life flow out from this place like a spring of living water. May the William Pepper Laboratory of Clinical Medicine be one more instrument in our hands to fulfil the reason for the University's existence, which, in the words of our charter, show that we were "established to be the means through the blessings of Almighty God of raising up men of dispositions and qualifications beneficial to the public, and as an institution of the most essential consequence to the good government of states, to the peace and welfare of society, and to be a public blessing to mankind."

In this spirit the trustees of the University accept the gift.

3. THE EVOLUTION OF MODERN SCIENTIFIC LABORATORIES.

BY DR. WILLIAM H. WELCH.

MR. PROVOST, LADIES, AND GENTLEMEN,—The scientific discoveries of the present century have had such a profound influence upon inventions, upon industries, and upon the comfort, health, and welfare of the people in general that there is wide-spread, even if not always adequate, appreciation of the value of scientific study and investigation. But it may be doubted whether there is any proper understanding in the minds even of the educated public of the material circumstances which surround scientific discovery and which make it possible. The average man, if interested at all, is interested that the discovery is made, not how it is made.

In this country, where we must rely mainly upon enlightened private beneficence, and not upon governmental aid, to furnish the pecuniary resources which are essential for scientific progress, it is important that there should be some general information not only regarding the results of scientific work, but also regarding the external material conditions necessary for the fruitful prosecution of such work.

At the present day the systematic study and advancement of any physical or natural science, including the medical sciences, requires trained workers who can give their time to the work, suitably constructed work-rooms, an equipment with all of the instruments and appliances needed for the special work, a supply of the material to be studied, and ready access to the more important books and journals containing the special literature of the science.

All of these conditions are supplied by a well-equipped and properly organized laboratory. Such laboratories are, with the partial exception of the anatomical laboratory, entirely the creation of the present century, and for the most part of the last fifty years. They have completely revolutionized during the past half-century the material conditions under which scientific work is prosecuted. They

are partly the result, and in larger part the cause, of that rapid progress of the physical and natural sciences which characterizes the era in which we are living.

The evolution of the modern laboratory still awaits its historian. It is not difficult to find incidental references to historical facts bearing upon this subject. The development of the chemical laboratory has been traced with some fulness. But it is curious that there is no satisfactory monographic treatment of the general subject of the historical development of scientific laboratories. The subject seems to me an attractive one. It would surely be interesting to trace the development of the teaching and the investigating laboratory back to its beginnings, to learn about the material circumstances under which the physicists, the chemists, the morphologists, and the physiologists of former generations worked. What share in the development of laboratories had the learned academies of the Renaissance and of the subsequent centuries? What share had public and private museums and collections of instruments of precision? What share had the work of the exact experimentalists, beginning with Galileo, of physicians, of the alchemists, and of the apothecaries? What individuals, universities, corporations, and governments were the pioneers in the establishment of laboratories for the various physical and natural sciences? The detailed consideration of these and many other questions pertinent to the subject would make an interesting and valuable historical contribution.

There is evidence that in Alexandria, under the early Ptolemies in the third century before Christ, there existed state-supported institutes, in which students of man and of nature could come into direct personal contact with the objects of study, and by the aid of such appliances as were then available could carry on scientific investigations. The practical study of anatomy, physiology, pathology, and other natural sciences was here cultivated. We are very imperfectly informed as to the results and the material circumstances of this remarkable period in the history of science. We know that after about a century of healthy activity the Alexandrian school gradually sank into a place for barren dialectics and metaphysical discussions.

Fifteen hundred years elapsed before we next find any record of the practical study of a natural science. In 1231, the great Hohenstaufen, Frederick the Second, who has been called the most remark-

able historic figure of the Middle Ages, commanded the teachers at Salernum diligently to cultivate the practical study of anatomy. After the passage of this edict occasional dissections of the human body were made, but it cannot be said that there was any diligent cultivation of anatomy on the part either of teachers or of students during the following two centuries.

In the latter half of the fifteenth century there developed that active interest in the practical study of human anatomy which culminated in the immortal work of Vesalius, published in 1543. After this the study of anatomy by dissections gradually assumed in the medical curriculum that commanding position which it has maintained up to the present day.

For over six hundred years there has been at least some practical instruction in anatomy, and for over three hundred years there have existed anatomical laboratories for purposes of teaching and of investigation, although only those constructed during the present century meet our ideas of what an anatomical laboratory should be. It is a matter of no little interest, both for the history of medicine and for that of science in general, that the first scientific laboratory was the anatomical laboratory. Private laboratories for investigation must have existed from the earliest times. Doubtless Aristotle had his laboratory. But the kind of laboratory which we have on this occasion in mind is one open to students or investigators or both. There was no branch of physical or natural science, with the exception of anatomy, which students could study in the laboratory until after the first quarter of the present century. Only in anatomy could students come into direct contact with the object of study and work with their own hands and investigate what lay below the surface.

That famous Moravian writer on education, Amos Comenius, over two hundred and fifty years ago, gave vigorous expression to the conception of living, objective teaching of the sciences. He said, "Men must be instructed in wisdom so far as possible, not from books, but from the heavens, the earth, the oaks, and the beeches,—that is, they must learn and investigate the things themselves, and not merely the observations and testimonies of other persons concerning the things." "Who is there," he cries, "who teaches physics by observation and experiment instead of by reading an Aristotelian or other text-book?" But how little ripe were the conditions then existing for the success-

ful carrying out of ideas so far in advance of his times is illustrated by the very writings of the author of "*Orbis Pictus*" and "*Lux in Tenebris*."

It would lead too far afield to trace in detail on this occasion the development of physical and of chemical laboratories, but on account of the intimate connection between the development of physics and chemistry and that of medicine, especially of more exact experimental work in the medical sciences, a few words on this subject will not be out of place.

Methodical experimentation in the sciences of nature was definitely established by Galileo and was zealously practised by his contemporaries and successors in the seventeenth century. It was greatly promoted by the foundation during this century of learned societies, such as the *Accademia dei Lyncei* and the *Accademia del Cimento* in Italy, the *Collegium Curiosum* in Germany, the *Académie des Sciences* in Paris, and the *Royal Society* in England. Much of the classical apparatus, still employed in physical experiments, was invented at this period. Experimental physics from the first acquired a kind of fashionable vogue, and this aristocratic position it has ever since maintained among the experimental sciences. These sciences must concede to physics that commanding position which it has won by the genius of the great natural philosophers, by the precision of its methods and the mathematical accuracy of its conclusions, and by the fundamental nature and profound interest and importance of its problems. The debt of the medical sciences to the great experimental physicists, from Kepler and Galileo and Newton down to Helmholtz, is a very large one, larger than is probably appreciated by medical men who have not interested themselves in the history of experimental and precise methods in medicine.

There existed in the last century cabinets of physical apparatus to be used in demonstrative lectures, but they were very inadequate, and suitable rooms for experimental work scarcely existed. It was not until about the middle of the present century that we find the beginnings of the modern physical laboratory, and it was as late as 1863 that Magnus opened in Berlin his laboratory for experimental physical research. Since 1870 there has been a rapid development of those splendid physical institutes which are the pride of many universities.

Humbler but more picturesque was the origin of the chemical lab-

oratory. This was the laboratory of the alchemist searching for the philosopher's stone. In the painter's canvas we can still see the vaulted, cob-webbed room with its dim and mysterious light, the stuffed serpent, the shelves with their many-colored bottles, the furnace in the corner with the fire glowing through the loose bricks, the fantastic alembics, the old alchemist in his quaint arm-chair reading a huge, worm-eaten folio, and the assistant grinding at the mortar. Fantastic and futile as it all may seem, yet here was the birth of modern chemistry. The alchemists were the first to undertake the methodical experimental investigation of the chemical nature of substances. No more powerful stimulus than the idea of the philosopher's stone could have been devised to impel men to ardent investigation. But search for gold was not all that inspired the later alchemists. Paracelsus, the alchemist, that strange but true prophet of modern medicine as he was of modern chemistry, said, "Away with these false disciples who hold that this divine science, which they dishonor and prostitute, has no other end but that of making gold and silver. True alchemy has but one aim and object, to extract the quintessence of things, and to prepare arcana, tinctures, and elixirs which may restore to man the health and soundness he has lost." And again he says of the alchemists, "They are not given to idleness nor go in a proud habit or plush or velvet garments, often showing their rings upon their fingers, or wearing swords with silver hilts by their sides, or fine and gay gloves upon their hands, but diligently follow their labors, sweating whole days and nights by their furnaces. They do not spend their time abroad for recreation, but take delight in their laboratory. They wear leather garments with a pouch and an apron wherewith to wipe their hands. They put their fingers among coals and into clay, not into gold rings."

During the seventeenth and eighteenth centuries the doctrines and work of the alchemists had profound influence upon medicine. Alchemy was not completely overthrown until Lavoisier gave the death-blow to the phlogistic theory of Stahl. But for a considerable time before Lavoisier introduced the new spirit into chemistry, its methods and its problems were gradually approaching those of modern times. It was, however, over thirty years after the tragic death of Lavoisier before the first chemical laboratory in the modern sense was established. One cannot read without combined feelings of wonder

and pity of the incommodious, forlorn, and cramped rooms in which such men as Scheele and Berzelius and Gay Lussac worked out their memorable discoveries. Liebig has graphically described the difficulties encountered by the student of that day who wished to acquire practical training in chemistry. With some of the apothecaries could be obtained a modicum of practical familiarity with ordinary chemical manipulations, but Sweden and France were the centres for those with higher aspirations.

It was the memory of his own experiences which led Liebig, immediately after he was appointed professor of chemistry in Giessen in 1824, to set about the establishment of a chemical laboratory. Liebig's laboratory, opened to students and investigators in 1825, is generally stated to be the first modern public scientific laboratory. Although, as we shall see presently, this is not quite correct, it is certain that Liebig's laboratory was the one which had the greatest influence upon the subsequent establishment and organization not only of chemical laboratories, but of public scientific laboratories in general. Its foundation marks an epoch in the history of science and of scientific education. This laboratory proved to be of great import to medical science, for it was here, and by Liebig, that the foundations of modern physiological chemistry were laid.

The significance of this memorable laboratory of Liebig is not that it was a beautiful or commodious or well-equipped laboratory, for it possessed none of these attributes,—indeed, it is said to have looked like an old stable,—but that here was a place, provided with the needed facilities and under competent direction, freely open to properly prepared students and investigators for experimental work in science.

The chemical laboratories of to-day are, in general, the best organized and the best supported of scientific laboratories.

The need of establishing physiological laboratories was recognized several years before the foundation of Liebig's laboratory. The important results to be derived from the application of the experimental method to the study of vital phenomena had been demonstrated first and most signally by Harvey, and after him by many experimenters. The fecundity of exact experimentation by physical and chemical methods applied to the phenomenon of life had been shown by the classical researches of Lavoisier on respiration and animal heat. Magendie had entered upon that remarkable scientific

career which entitles him to be regarded as the founder of modern experimental physiology, pathology, and pharmacology.

In 1812, Gruithuisen, who after the custom of the times filled an encyclopædic chair, being professor in Munich of physics, chemistry, zootomy, anthropology, and later of astronomy, published an article advocating the establishment of physiological institutes. In 1823, Purkinje, one of the most distinguished physiologists of this century, accepted the professorship of physiology in Breslau, this being the first independent chair of physiology in any German university. In 1824, Purkinje succeeded in establishing a physiological laboratory, which therefore antedates by one year Liebig's chemical laboratory in Giessen, although it cannot be said to have exercised so great an influence upon the organization of scientific laboratories in general as did the latter. In 1840, Purkinje obtained a separate building for his laboratory.

With two or three exceptions all of the separate physiological laboratories worthy of the name have been established since the middle of the present century. Bernard, that prince of experimenters, worked in a damp, small cellar, one of those wretched Parisian substitutes for a laboratory which he has called "the tombs of scientific investigators." There can be no greater proof of the genius of Bernard than the fact that he was able to make his marvellous discoveries under such obstacles and with such meagre appliances. France was long in supplying her scientific men with adequate laboratory facilities, but no more unbiassed recognition of the value and significance of the German laboratory system can be found than in the reports of Lorain, in 1868, and of Wurtz, in 1870, based upon personal study of the construction and organization of German laboratories.

Of modern physiological laboratories, the one which has exerted the greatest and most fruitful influence is unquestionably that of the late Professor Ludwig in Leipzig. This unequalled position it has won by the general plan of its organization, its admirable equipment, the number and importance of the discoveries there made, its development of exact methods of experimentation, the personal character and genius of its director, and the number of experimenters there trained from all parts of the civilized world.

To-day every properly equipped medical school has its physiological

laboratory. This department is likely to continue to hold its place as the best representative of exact experimental work in any medical science. A good knowledge of physiology is the best corrective of pseudo-scientific, irrational theories and practice in medicine.

Physiological chemistry has been an important department of research for over half a century, but it is only within recent years that there have been established independent laboratories for physiological chemistry. A large part of the work in this branch of science has been done hitherto in laboratories of general chemistry, of physiology, of pathology, and of clinical medicine. A physiological laboratory cannot well be without a chemical department, and the same is true of several other medical laboratories; but it seems to me that physiological chemistry has won its position as an independent science, and will be most fruitfully cultivated by those who with the requisite chemical and biological training devote their entire time to it. The usefulness of independent laboratories for physiological chemistry has been shown by the work done in Hoppe-Scyler's laboratory, first in Tübingen from 1861 to 1872, and after 1872 in Strassburg.

The first pathological laboratory was established by Virchow, in Berlin, in 1856. About this time he wrote: "As in the seventeenth century anatomical theatres, in the eighteenth clinics, in the first half of the nineteenth physiological institutes, so now the time has come to call into existence pathological institutes, and to make them as accessible as possible to all." It cannot be doubted that the time was fully ripe for this new addition to medical laboratories. Virchow secured his laboratory as a concession from the Prussian government upon his return from Würzburg to Berlin. Virchow's laboratory has been the model as regards the general plan of organization for nearly all pathological laboratories subsequently constructed in Germany and in other countries. It embraced opportunities for work in pathological anatomy, experimental pathology, and physiological and pathological chemistry. This broad conception of pathology and of the scope of the pathological laboratory as including the study, not only of diseased structure, but also of disordered function and as employing the methods, not only of observation, but also of experiment, should never be lost sight of.

The first to formulate distinctly the conception of pharmacology as an experimental science distinct from therapeutics and closely allied

by its methods of work and by many of its problems to physiology was Rudolph Buchheim. This he did soon after going to Dorpat in 1846 as extraordinary professor of materia medica, and it was apparently not long after he there became ordinarius in 1849, that he established a pharmacological laboratory in his own house and by his private means. Later, this laboratory became a department of the University and developed most fruitful activity. Buchheim's laboratory was the first pharmacological laboratory in the present acceptance of this term. The conception of pharmacology advocated by Buchheim has been adopted in all German universities, and in not a few other universities, but it cannot be said to have been as yet generally accepted in the medical schools of this country and of Great Britain, although it seems destined to prevail.

The medical science which was the latest to find domicile in its own independent laboratory is hygiene. To Pettenkofer belongs the credit of first establishing such a laboratory. Since 1847 he had been engaged with hygienic investigations, and in 1872 he secured from the Bavarian government the concession of a hygienic institute. This admirably equipped laboratory was opened for students and investigators in 1878. By this time Koch had already begun those epochal researches which, added to the discoveries of Pasteur, have introduced a new era in medicine. The introduction by Koch of new methods of investigating infectious diseases and many hygienic problems became the greatest possible stimulus for the foundation of laboratories of hygiene and bacteriology, and to some extent also of laboratories of pathology. The results already achieved by these new methods and discoveries in the direction of prevention and cure of disease, and the expectation of even more important results in the future, constitute to-day our strongest grounds of appeal to governments and hospitals and medical schools and the general public for the establishment and support of laboratories where the nature, the causes, the prevention, and the cure of disease shall be investigated. You have established here, in this city, and in connection with this University, the first hygienic laboratory of this country, housed in its own building and assured, I believe, of a future of great usefulness.

It is apparent, from the brief and imperfect outline which I have presented of the evolution of modern scientific laboratories, that the birthplace of these laboratories, regarded as places freely open for

instruction and research in the natural sciences, was Germany. Such laboratories are the glory to-day of German universities, which possess over two hundred of them. By their aid Germany has secured since the middle of the present century the palm for scientific education and discovery.

Great scientific investigators are not limited to any country or any time. There are those of surpassing ability who will make their own opportunity and will triumph over the most discouraging environment. This country and every civilized country can point to such men, but they are most exceptional. The great majority of those even with the capacity for scientific work need encouragement and opportunity. We now have sufficient knowledge of the workings of scientific laboratories to be able to assert that in general where the laboratory facilities are the most ample and the most freely available, there are developed the largest number of trained workers, and there the discoveries are the most numerous and the most important. At the present day no country, no university, and no medical school can hold even a respectable place in the march of education and progress unless it is provided with suitable laboratories for scientific work.

A properly equipped and properly conducted scientific laboratory is a far more expensive institution than is usually conceived. It must be suitably domiciled either in a separate building or in rooms commodious and well lighted. The outside architectural features are of secondary importance. The instruments and appliances necessary for exact observation and experiment, even in those sciences which apparently require the least, are numerous and costly. A working library, containing the books and sets of journals most frequently consulted, is most desirable, if not absolutely indispensable. The director of the laboratory should be a man of ability and experience, who is a master in his department of science. He must have at least one assistant, who is preferably a young man aiming to follow a scientific career. A person of no small value in the successful working of the laboratory is the intelligent janitor or "diener," who can be trained to do the work of a subsidiary assistant and can be intrusted with the care and manipulation of instruments. There must be funds for the purchase of fresh supplies and new instruments when needed. The running expenses of a first-class laboratory are not small.

But, costly as may seem the establishment and support of a good

laboratory, the amount of money expended for laboratories would seem to us ridiculously insignificant if we could estimate the benefits to mankind derived from the work which has been done in them. Wurtz has truly said of the money required for laboratories, "It is a capital placed at a high rate of interest, and the comparatively slight sacrifice imposed upon one generation will bring to following generations increase of well-being and knowledge."

The educational value of the laboratory cannot well be overestimated. For the general student this is to be found primarily in the development of the scientific habit of thought. He learns that to really know about things, it is necessary to come into direct contact with them and study them. He finds that only this knowledge is real and living, and not that which comes from mere observation of external appearances, or from reading or being told about things, or, still less, merely thinking about them.

The problem of securing for the student of medicine the full benefits of laboratory instruction in the various medical sciences is a very difficult one, and cannot, I believe, be solved without considerable readjustment of existing schemes of medical teaching, but this subject is one which I cannot attempt to consider here.

The whole face of medicine has been changed during the last half-century by the work of the various laboratories devoted to the medical sciences. Anatomy, physiology, and pathology now rank among the most important of the sciences of nature. They have been enriched with discoveries of the highest significance and value not only for medicine, but also for general biology. Although we have not penetrated, and may never penetrate, the mystery of life, we are coming closer and closer to an understanding of the intimate structure and the fundamental properties of living matter. We already know that living matter is not that homogeneous, formless substance which, not many years ago, it was believed to be, but that it possesses a complex organization.

Practical medicine has been profoundly influenced by the unparalleled development of the medical sciences during the last fifty years, and especially during more recent years. Scientific methods have passed from the laboratory to the hospital. Cases of disease are now studied with the aid of physical and chemical and microscopical and bacteriological methods. The diagnosis of disease has thereby been

greatly advanced in precision, and if Boerhaave's motto, *qui bene diagnoscit, bene medebitur*, be true, there should be a corresponding advance in the results of the treatment of disease. Whether or not this dictum of the old master be true,—and I have serious doubts as to its entire truth,—it cannot be doubted that great progress has been made in surgical, and to some extent in medical, treatment as a result of scientific discoveries, although the treatment of disease still rests, and will doubtless long continue to rest, largely upon empirical foundations.

We are assembled here to-day to assist at the opening of a laboratory which gives the fittest and strongest possible expression to the influence of scientific work upon practical medicine. The generous founder has marked with characteristic insight the direction in which the current is setting.

The conception of a thoroughly equipped laboratory as an integral part of a hospital and intended for the study and investigation of disease is of recent origin. The germs of this idea, however, may be traced back to such men as Hughes Bennett and Beale in Great Britain, and to Frerichs and Traube in Germany, who in their hospital work made fruitful application of microscopical, chemical, and experimental methods. A little over ten years ago, von Ziemssen, in Munich, established a well-conceived clinical laboratory, containing a chemical, a physical, and a bacteriological department, a working library, and rooms for practical courses and the examination of patients. A similar laboratory was secured by Cuschmann in Leipzig in 1892.

The growing recognition of the need of such laboratories is the result of the great progress in scientific medicine during recent years. The thorough clinical examination of many cases of disease now requires familiarity with numerous technical procedures, physical, chemical, microscopical, and bacteriological. The laboratory outfit required simply for routine clinical examinations is considerable. A microscope and a few test-tubes and chemical reagents for simple tests of the urine no longer suffice. As illustrations of this, I call attention to the clinical value of examinations of the blood, of the contents of the stomach, of fluids withdrawn from the serous cavities, of the sputum and various secretions, of fragments of tissue removed for diagnosis. Such examinations require much time, trained observers,

and considerable apparatus. To secure for the patients the benefits in the way of diagnosis, prognosis, and treatment to be derived from these methods of examination, a hospital should be supplied with the requisite facilities.

A hospital, and especially one connected with a medical school, should serve not only for the treatment of patients, but also for the promotion of knowledge. Where this second function is prominent, there also is the first most efficiently and intelligently carried out. Herein we see the far-reaching beneficence of a laboratory, such as this one, thoroughly equipped to investigate the many problems which relate to clinical medicine.

The usefulness of an investigating laboratory in close connection with a hospital has already been abundantly demonstrated. Chemical studies, such as those relating to metabolism in various acute and chronic affections, microscopical and chemical investigations of the blood and bacteriological examinations of material derived directly from the patient, may be mentioned as directions in which researches conducted in hospital laboratories have yielded important results and will garner still richer harvests in the future.

There need be no conflict between the work of clinical laboratories and that of the various other medical laboratories. Each has its own special field, but it is not necessary or desirable to draw around these fields sharp boundary lines beyond which there shall be no poaching. It will be a relief to pathological and other laboratories to have certain examinations and subjects relating directly to practical medicine consigned to the clinical laboratory where they can receive fuller and more satisfactory consideration. The subject-matter for study in the clinical laboratory is primarily the patient and material derived from the patient. Anatomical, physiological, pathological, pharmacological, and hygienic laboratories must concern themselves with many problems which have apparently no immediate and direct bearing upon practical medicine. In the long run their contributions are likely to prove most beneficial to medicine if broad biological points of view, rather than immediate practical utility, are their guiding stars. The clinical laboratory will concern itself more particularly with questions which bear directly upon the diagnosis and the treatment of disease.

To the small number of existing well-equipped clinical laboratories

the William Pepper Laboratory of Clinical Medicine is a most notable addition. It is the first laboratory of the kind provided with its own building and amply equipped for research in this country, and it is not surpassed in these respects by any in foreign countries. It is intended especially for investigation and for the training of advanced students. It is a most worthy memorial of the father of its founder.

William Pepper the elder was a very distinguished physician and trusted consultant of this city, for many years an attending physician at the Pennsylvania Hospital, where he was a clinical teacher of great influence, and for four years the professor of the theory and practice of medicine in this University. He belonged to that remarkable group of American physicians, trained under Louis, who brought to this country the best methods and traditions of the French school of medicine at the time of its highest glory. His diagnostic powers are said to have been remarkable. With his broad sympathies, his high ideals, and his active and enlightened efforts for the promotion of clinical medicine, how he would have welcomed such opportunities as will be afforded by this laboratory to contribute to a better knowledge of the nature, the diagnosis, and the treatment of disease!

Our country has until within a very few years been deprived of the encouragement and opportunities for original investigations in the medical sciences afforded by large and thoroughly equipped laboratories. We can still count upon the fingers of one hand our medical laboratories which are comparable in their construction, organization, and appliances to the great European laboratories. Notwithstanding these obstacles, there have been American physicians of whose contributions to medical science we may feel proud.

But a new era has dawned. Of that we are witnesses here to-day. The value of medical laboratories is now widely recognized in this country. To those of us who appreciate the underlying currents in medicine, who follow eagerly the almost feverish activities and the quick succession of important discoveries in foreign medical laboratories, and who understand the significance of the great medical problems which now require only intelligent, patient work and suitable opportunities for their solution, our laboratories may seem slow in coming, but they will in time be provided by enlightened benevolence. The individual or institution or hospital which contributes to

the establishment of a good laboratory devoted to any of the medical Sciences merits in unusual degree the gratitude of all medical men ; yes, of every true friend of humanity. Such gratitude we feel for the generous and public-spirited founder of this laboratory, who has contributed largely to the advancement of medicine in this country, and of whose splendid services to this University I need not speak in this presence.

I congratulate this city and this university and this hospital upon the important addition made by this laboratory to higher medical education and the opportunities for scientific work in this country. May the enlightened aims of the founder, and the hopes of all interested in the promotion of medicine in this country, be fulfilled by the scientific activities which will now begin in the William Pepper Laboratory of Clinical Medicine.

